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**U.S. Department of Labor, OSHA
Billings Area Office**

**DEQ
Planning Division**

**Industrial Hygiene Survey of Park Employee Exposures During Winter Use
at Yellowstone National Park
February 19 through February 24, 2000**

I. INTRODUCTION & SUMMARY

A survey was conducted to examine employee exposures and evaluate current exposure control methods during winter use in Yellowstone National Park. This survey incorporated both area and personal samples for benzene, gasoline, formaldehyde, carbon monoxide, diesel exhaust, welding fume, and noise. Sampling took place during February 19, 2000 to February 24, 2000. Samples were collected at the following locations: 1) West Entrance, 2) Old Faithful Maintenance Shop, 3) Lake Maintenance Shop, and , 4) Mammoth Maintenance Shop. In addition, a number of Park Rangers in these various areas were also sampled for their exposure to noise while riding snowmobiles. The results of the air samples were compared to the acceptable limits set by the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), and the American Conference of Governmental Industrial Hygienists (ACGIH). The results of the noise samples were compared to the acceptable limits set in the OSHA standard for noise exposure, 29 CFR 1910.95. There were no exposures above any OSHA permissible exposure limits (PEL) for any of the air contaminants. There were also no exposures above any of the ACGIH Threshold Limit Values (TLV). There were exposures above the NIOSH Recommended Exposure Levels (REL). The over exposures occurred both as an 8-hour time-weighted average and as the average

concentration for the time period sampled. These over exposures occurred during the collection of airborne benzene, formaldehyde, and carbon monoxide. One employee working in the express lane primarily outside the Kiosk booth at the West Entrance was overexposed to benzene and formaldehyde as an 8-hour time-weighted average, over exposed to carbon monoxide as a peak concentration, and over exposed to noise during the admission of snowmobiles into the park. This employee's exposure to benzene was measured at 0.1881 ppm, which exceeds the REL of 0.1000 ppm. The formaldehyde exposure was measured at 0.0332 ppm which exceeds the REL of 0.016ppm, and the carbon monoxide exposure was measured at a peak concentration of 268ppm which exceeds the REL peak exposure limit of 200 ppm. Personal and area samples showed that the Kiosk ventilation system at the west entrance was adequate to control employee exposures when they worked inside the Kiosk. Noise exposure for this employee was measured at 88 decibels as an 8-hour time-weighted average which exceeds the OSHA action level of 85 decibels. The snowmobile mechanic at the Lake Maintenance Shop was over exposed to benzene during the time period sampled. This exposure was measured at 0.1058 ppm. A West District Patrol Ranger stationed out of the West Entrance was over exposed to noise at a level of 93 decibels which exceeds the PEL of 90 decibels. Adequate hearing protection was provided for both the patrol ranger and the kiosk employee, but the employees were not included in the park hearing conservation program.

The primary reason for low employee exposures corresponded directly to the time the employee was exposed to the hazardous atmosphere. Employees sampled generally were not exposed to a constant high level of atmospheric contaminant for a work shift. The ACGIH recommends for known carcinogens such as benzene and formaldehyde that the levels be kept as low as feasibly possible below the TLV.

II. METHODS AND RESULTS

A. BENZENE

Repeated or prolonged exposure to benzene, even at relatively low concentrations, may result in various blood disorders, ranging from anemia to leukemia. Many blood disorders associated with benzene exposure may occur without symptoms. Benzene was measured using both area and personal samples. Both samples were obtained using a sample train that included an SKC charcoal tube (100/50 mg sections, 20/40 mesh), tygon tubing, a Dupont Alpha 2 pump calibrated to draw air at a rate of 0.2 liters per minute. The sampling media was worn on a shirt or jacket lapel as close as possible to the breathing zone of the employee. All samples were analyzed by the OSHA Salt Lake Technical Center Laboratory. Table I below summarizes the results of the benzene samples. The table column heading of labeled as, Result, gives the sample result for the time period sampled. The, TWA, column heading gives the sample result calculated as an 8-hour time-weighted average. The shaded area of the table indicates an over exposure to the NIOSH REL. This formatting is followed in all of the tables provided in this report.

Table I. Benzene Sample Results

Location	Result	TWA	OSHA PEL	NIOSH REL	ACGIH TLV
2/19/00 West Entrance					
Kiosk Attendant 1	0.0266	0.0200	1 ppm	0.1 ppm	0.5 ppm
Kiosk Attendant 2	0.0210	0.0087	1 ppm	0.1 ppm	0.5 ppm
Kiosk Attendant 3	0.1881	0.1118	1 ppm	0.1 ppm	0.5 ppm
Area North Kiosk	0.0071	----	1 ppm	0.1 ppm	0.5 ppm

Ventilation System Intake	0.0062	----	1 ppm	0.1 ppm	0.5 ppm
2/20/00 West Entrance					
Kiosk A Inside	0.0079	----	1 ppm	0.1 ppm	0.5 ppm
Kiosk A Outside	0.0816	----	1 ppm	0.1 ppm	0.5 ppm
Kiosk B Outside	0.0110	----	1 ppm	0.1 ppm	0.5 ppm
Kiosk C Inside	0.0124	----	1 ppm	0.1 ppm	0.5 ppm
Kiosk C Outside	0.0475	----	1 ppm	0.1 ppm	0.5 ppm
2/22/00 Lake Shop					
Snowmobile Mechanic	0.1058	0.0286	1 ppm	0.1 ppm	0.5 ppm
Area-Parts Room	0.0620	----	1 ppm	0.1 ppm	0.5 ppm
Area-Mechanic Shop	0.0718	----	1 ppm	0.1 ppm	0.5 ppm
2/23/00 Old Faithful Shop					
Area - Front End Loader Exhaust (Diesel)	0.0000	----	1 ppm	0.1 ppm	0.5 ppm
2/24/00 Mammoth Shop					
Snowmobile Mechanic	0.0543	0.0424	1 ppm	0.1 ppm	0.5 ppm

B. GASOLINE

Gasoline causes irritation to the eyes, nose, and throat and central nervous system effects such as headaches and nausea. Gasoline was measured using both area and personal samples. Both samples were obtained using a sample train that included an SKC charcoal tube (100/50 mg sections, 20/40 mesh), tygon tubing, a Dupont Alpha 2 pump calibrated to draw air at a rate of

0.2 liter per minute. The sampling media was worn on a shirt or jacket lapel as close as possible to the breathing zone of the employee. All samples were analyzed by the OSHA Salt Lake Technical Center Lab. Table II below summarizes the results of the gasoline samples.

Table II. Gasoline Sample Results

Location	Result	TWA	OSHA PEL	NIOSH REL	ACGIH TLV
2/19/00 West Entrance					
Kiosk Attendant 1	4.7960	3.3972	No PEL	No REL	300 ppm
Kiosk Attendant 2	3.5848	1.4787	No PEL	No REL	300 ppm
Kiosk Attendant 3	22.015	13.118	No PEL	No REL	300 ppm
Area North Kiosk	1.1588	----	No PEL	No REL	300 ppm
Ventilation System Intake	1.0193	----	No PEL	No REL	300 ppm
2/20/00 West Entrance					
Kiosk A Inside	1.4949	----	No PEL	No REL	300 ppm
Kiosk A Outside	6.5524	----	No PEL	No REL	300 ppm
Kiosk B Outside	7.7071	----	No PEL	No REL	300 ppm
Kiosk C Inside	1.3688	----	No PEL	No REL	300 ppm
Kiosk C Outside	5.4116	----	No PEL	No REL	300 ppm
2/22/00 Lake Shop					
Snowmobile Mechanic	19.0295	5.1538	No PEL	No REL	300 ppm
Area - Parts Room	10.6928	----	No PEL	No REL	300 ppm
Area - Mechanic Shop	12.4442	----	No PEL	No REL	300 ppm
2/23/00 Old Faithful Shop					

Area - Front End	0.9240	----	No PEL	No REL	300 ppm
Loader Exhaust (Diesel)					
2/24/00 Mammoth					
Shop					
Snowmobile Mechanic	13.773	10.760	No PEL	No REL	300 ppm

C. FORMALDEHYDE

Formaldehyde causes eye, nose, and throat irritation and bronchial spasms. Formaldehyde exposure has been associated with cancers of the lung, nasopharynx, and oropharynx, and nasal passages. Formaldehyde was measured using both area and personal samples. Both samples were obtained using a sample train that included an XAD-2 tube coated with 10% 2-Hydroxymethyl piperidine (150/75 mg sections, 20/60 mesh), tygon tubing, a Dupont Alpha 2 pump calibrated to draw air at a rate of 0.1 liters per minute. The sampling media was worn on a shirt or jacket lapel as close as possible to the breathing zone of the employee. All samples were analyzed by the OSHA Salt Lake Technical Center Lab. Table III below summarizes the results of the formaldehyde samples.

Table III. Formaldehyde Sample Results

Location	Result	TWA	OSHA PEL	NIOSH REL	ACGIH TLV
2/19/00 West Entrance					
Kiosk Attendant 1	0.0000	0.0000	0.75 ppm	0.016 ppm	
Kiosk Attendant 2	0.0000	0.0000	0.75 ppm	0.016 ppm	
Kiosk Attendant 3	0.0759	0.0332	0.75 ppm	0.016 ppm	

Area- North Kiosk	0.00	----	0.75 ppm	0.016 ppm	
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D. CARBON MONOXIDE

Carbon monoxide inhalation decreases the amount of oxygen available to internal organs and tissues causing headaches, nausea, dizziness and confusion. Carbon monoxide was measured with a direct reading Drager 190 Datalogger which measured both peak and time weighted average exposures. Table IV below summarizes the results of the carbon monoxide samples. The shaded area denotes the over exposure to the peak concentration of 200 ppm. Exposure above this level should not occur at any time during the employee's work shift.

Table IV. Carbon Monoxide Sample Results

Location	Result	TWA	OSHA PEL	NIOSH REL	ACGIH TLV
2/19/00 West Entrance					
Kiosk Attendant 1	3	1	50 ppm	35 ppm	25 ppm
Kiosk Attendant 2	3	2	50 ppm	35 ppm	25 ppm
Kiosk Attendant 3	19 268	14	50 ppm	35 ppm 200 (Peak)	25 ppm
Area - North Kiosk	0	----	50 ppm	35 ppm	25 ppm
Ventilation System Intake	0	----	50 ppm	35 ppm	25 ppm
2/20/00 West Entrance					
Kiosk A Inside	0	----	50 ppm	35 ppm	25 ppm
Kiosk A Outside	2	----	50 ppm	35 ppm	25 ppm
Kiosk B Outside	0	----	50 ppm	35 ppm	25 ppm

Kiosk C Inside	2	----	50 ppm	35 ppm	25 ppm
Kiosk C Outside	8	----	50 ppm	35 ppm	25 ppm
2/22/00 Lake Shop					
Snowmobile Mechanic	11	3	50 ppm	35 ppm	25 ppm
Area - Parts Room	10	----	50 ppm	35 ppm	25 ppm
2/24/00 Mammoth Shop					
Snowmobile Mechanic	3	2	50 ppm	35 ppm	25 ppm
Area -Repair Shop	6	----	50 ppm	35 ppm	25 ppm
Area - Dock	6	----	50 ppm	35 ppm	25 ppm
Construction					

E. NOISE

Overexposure to noise in the work environment causes hearing loss that is a permanent condition that cannot be treated medically. Exposure to noise at level equal to or exceeding the PEL may cause a shift in the worker’s hearing threshold. In addition to effects on hearing, noise interferes with speech, causes a stress reaction, lowers morale, reduces efficiency, and causes fatigue. Noise samples were taken with a Dupont MK-2 noise dosimeter. Table V below shows the results of the noise sampling expressed in decibels.

Table V. Noise Exposures

2/19/00 West Entrance	Result	OSHA Action Level	OSHA PEL
Ranger Patrol	93.1	85	90

Kiosk Attendant 1	72.1	85	90
Kiosk Attendant 2	75.2	85	90
Kiosk Attendant 3	88.3	85	90

G. DIESEL EXHAUST

Due to the fact that very little diesel equipment is operated in the shops during the winter, the sampling conducted was very limited. Sampling was conducted at the Mammoth Shop where an area sample was set in the wash bay where two sand trucks were parked. Both sand trucks were started and left running for a time period that employees estimated they would normally run before leaving the garage. These samples were collected on specially prepared filter media using personal sampling pumps calibrated to a flow rate of 2.0 liters per minute. These samples were analyzed at the OSHA Salt Lake City Laboratory using a thermal optical analyzer. The samples were analyzed for elemental and organic carbon. No detectable levels were measured on these samples. We recommend that diesel exhaust sampling be conducted during the season when diesel equipment is being operated in the shops more frequently.

G. WELDING FUME

When welding is performed on carbon steel metal surfaces which do not contain coatings, then iron oxide is the main fume which is liberated. Iron oxide is relatively non-toxic and only at high concentration does it have irritation effects in the upper respiratory tract. When welding is performed on surfaces coated with zinc, then zinc oxide will be liberated. Zinc oxide causes metal fume fever with flu-like symptoms including fever with chills, tightness in the chest and coughing. When welding is performed on surfaces coated with paint, lead fumes may be liberated. Consistent

over exposure to lead may result in severed damage to the blood-forming, nervous, urinary and reproductive systems. The sample train included a Dupont Alpha-2 pump, tygon tubing, and a mixed cellulose ester filter. Samples were collected at a flow rate of 1.7 liters per minute. The OSHA Salt Lake City Laboratory analyzed the samples for thirteen metals. The welding fume results are summarized in the table below. The units of exposure are expressed in milligrams of contaminant per cubic meter of air (mg/m³). The shaded area marked on the results for the area sample indicate that some lead was detected in this sample. Note that this was the area sample and not the personal sample. This may indicate that although the metal which was being welded at the time of sample collected did not contain any lead, the welding table surface may have had lead on it from previous welding jobs. Further sampling is recommended to determine if employees welding in this area are being exposed to lead.

Table VII. Welding Fume Results

2/23/00 Old Faithful	Result	TWA	OSHA PEL	NIOSH REL	ACGIH TLV
Shop Mechanic					
Beryllium	0.0000	0.0000	0.002	0.0005	0.002
Cobalt	0.0000	0.0000	0.100	0.05	0.02
Chromium	0.0000	0.0000	1.000	0.5	0.50
Copper Fume	0.0083	0.0006	0.100	0.1	0.20
Iron Oxide	0.0123	0.0008	10.000	5	5.00
Manganese Fume	0.0167	0.0012	5.000	1	0.20
Molybdenum	0.0000	0.0000	15.000	5	10.00
Nickel	0.0000	0.0000	1.000	0.015	1.00

Lead	0.0000	0.0000	0.050	0.1	0.05
Antimony	0.0000	0.0000	0.500	0.5	0.50
Vanadium	0.0000	0.0000	0.100	0.05	0.05
Zinc Oxide	0.0000	0.0000	5.000	5	5.00
WELDING - Area			mg/m³	mg/m³	mg/m³
Beryllium	0.0000	0.0000	0.002	0.0005	0.002
Cobalt	0.0000	0.0000	0.100	0.05	0.02
Chromium	0.0000	0.0000	1.000	0.50	0.50
Copper Fume	0.0049	0.0004	0.100	0.10	0.20
Iron Oxide	0.1218	0.0088	10.000	5.00	5.00
Manganese Fume	0.0067	0.0005	5.000	1.00	0.20
Molybdenum	0.0000	0.0000	15.000	5.00	10.00
Nickel	0.0000	0.0000	1.000	0.015	1.00
Lead	0.0126	0.0009	0.050	0.10	0.05
Antimony	0.0000	0.0000	0.500	0.50	0.50
Vanadium	0.0000	0.0000	0.100	0.05	0.05
Zinc Oxide	0.0000	0.0000	5.000	5.00	5.00

III. DISCUSSION & RECOMMENDATIONS

A. West Entrance

On February 19, 2000, approximately 976 snow machines entered the park at the west entrance. According to park personnel, this is average for a Presidents Day weekend. Kiosk attendant #3 was the employee working in the express lane. That employee was exposed above REL for benzene, formaldehyde and carbon monoxide. This employee was also over the action level for

1) Install a local exhaust ventilation system in the repair area. The hood design for this system should be similar to that used by the snowmobile mechanic at Mammoth. This hood can be placed directly over the exhaust. Testing was performed on this hood at the Mammoth garage. Results indicated that the hood captured almost 100% of the exhaust from the snowmobile.

C. Old Faithful Maintenance Shop

On February 23, area and personal sample for welding fumes were collected. The only result of concern was the area sample which detected low amounts of lead particulate. It is recommended that the welding operation in this area be further sampled.

D. Mammoth Maintenance Shop

On February 24, a personal sample for benzene, gasoline, formaldehyde and carbon monoxide was collected on the snowmobile mechanic. There were no results above any threshold limits. An area sample was also collected for diesel exhaust during the operation of two sand truck parked in the wash bay area. The trucks were left running for the time period they would typically run before they left the shop. No diesel exhaust was detected. It is recommended that further diesel exhaust testing be performed when more equipment is operated in the shop area.